ALTERNATIVE DIPOLE MAGNETS FOR ISABELLE*

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A dipole magnet design was developed by the Lawrence Berkeley Laboratory as a possible alternative for the ISABELLE project of the Brookhaven National Laboratory. Two developmental magnets with internal cold bores of 133mm and lengths of 1.3m were built and have been tested in He I at 4.3k and in He II at 1.8K.

A construction method has been developed in which the magnet coil structure is assembled without the use of adhesives in its final form on the coil winding fixture. Sufficient circumferential coil prestress is introduced during construction to prevent separation of the coils from their pole spacers under the action of the Lorentz forces induced during operation. This pre-stress is achieved by means of a tapered collet and structural ring system. The superconductor is standard Fermilab 23-strand Rutherford cable, insulated with 25μm Kapton and 50μm Mylar overlapping tapes. Three coil layers are used, arranged as partial shells around the bore in an intersecting ellipse configuration.

Both magnets were tested with iron (mild steel) structural rings for field enhancement; one was tested also with aluminum alloy rings. The design central field is 6.0T at 4.2K. The short-sample limit of 6.5T central field at 4.3K was reached after a small number of quenches, commencing at 5T. Operation in He II at 1.8K raised the field to 7.6T at a current density in the winding of 38A/cm^2. Fields were measured with Hall plates and magneto-resistive sensors. The iron rings began to saturate at a central field of 2T, and were fully saturated at the 6T design field.

Cyclic energy losses in these magnets were measured by a calorimetric method which is feasible only in He II and is described in another paper presented in this conference. Cycling one magnet from 0.6T to 6.5T at 0.47/s (25s full period) produced heat at the rate of 41W.

To determine the origin of quenches, one magnet was extensively instrumented with voltage taps on the coil and with acoustic sensors at each end of the magnet. Most quenches were seen to originate in the turn nearest the pole of the inner-layer coil, along the straight section. Quench propagation velocities along the cable varied from 5.8 so 22.6m/s, and turn-to-turn transfer times equivalent to azimuthal velocities of 0.042 to 0.015 m/s were measured also.

Magnet tests since June 1981 have been conducted in our large horizontal He II cryostat. This apparatus has a magnet chamber 0.56m in diameter, 1.4m in length. The gas-cooled current leads and the power supply are capable of 7000A operation. The cryostat has extensive temperature instrumentation. Liquid helium is supplied by a refrigerator rated at 200W at 4.2K, or about 70 liters of liquid per hour. For operation in He II, an auxiliary vacuum pump, operating as a closed-loop low pressure compressor, maintains a low pressure over liquid helium in a heat-exchange coil immersed in the main helium volume, accomodating a heat load of 30W. An external quench-detection and energy-extraction system limits the energy input to the helium bath during a magnet quench to about 25 percent of the stored energy.